

Amendments to the Claims

Claim 1. (Currently amended) A distributed ~~diagnostic and prognostic~~ system for monitoring ~~[[the]]~~ a health status and integrity of ~~conduits~~ at least one conduit, the system comprising:

a plurality of local health status and integrity monitoring devices each capable of inspecting the ~~health~~ status of local individual conduits and conduit components, each local monitoring device coupled to ~~having:~~

~~a centralized data~~ central processor ~~coupled by wired or wireless means~~ wireless ~~to the a plurality of local monitoring devices,~~ the ~~centralized~~ central data processor for receiving from each local monitoring device the local data concerning its associated conduits, for generating a set of ~~weighting parameters~~ data for each local conduit monitoring device, and for communicating the set of ~~weighting parameters~~ data to each local conduit monitoring device; and

each local monitoring device having a local data processor ~~of each local monitoring device further~~ for receiving the set of ~~weighting parameters~~ data, collecting data regarding the at least one local conduit and analyzing the local data using ~~[[the]]~~ a set of ~~weighting parameters~~ data for local ~~diagnostic and prognostic~~ health monitoring purposes ~~[[.]]~~ __

Claim 2. (Currently amended) ~~[[An]]~~ A monitoring device for use in monitoring at least one conduit with at least one conductor for diagnostic purposes, the monitoring device comprising:

at least one ~~programmed microcontroller or other~~ processor for the purpose of acquiring ~~[[the]]~~ sensor information from a set of sensors and sensitized medium, ~~conditioning and normalizing~~ processing the sensor information based on parameters and environmental condition of the conduit, and for processing the ~~normalized~~ information to provide an output signal indicative of the ~~diagnostic~~ condition and ~~[the prognostic]~~ an estimate of remaining useful life of the conduit and conductors it monitors~~[[.]]~~ , and

~~a set of sensors having outputs coupled to the programmed processor, at least one sensor being an environmental sensor for providing environmental information indicative of the local environmental condition, and sensors that are strips or strands of heterogeneous sensitized medium said medium either essentially opaque to signal transmission, or selected from the group of mediums that are capable of supporting or conducting an electrical current and voltage, an electromagnetic signal, an optical signal, an audio signal, and an indicating substance with the purpose to provide sensor information indicative of damage to the sensitized medium; with each sensor or strand of sensitized medium being positioned with~~

~~respect to the conduit to provide information concerning the environment and damage and deterioration to the conduit; and~~

~~means operatively associated with the programmed processor for operating the processor in a birth certificate mode wherein the outputs of the sensors are processed by the programmed processor and stored in as baseline operational parameters; and~~

means associated with the at least one programmed microcontroller or other processor for operating the device in a monitoring mode, after the at least one programmed microcontroller or other processor ~~program~~ has operated in the birth certificate mode, wherein the at least one programmed microcontroller or other processor acquires, conditions, and processes the data from the said set of sensors and sensitized strands ~~outputs from the sensors~~, compares the processed data ~~outputs~~ to previously stored data ~~the baseline operating parameters~~, and provides an indication of the ~~diagnostic~~ condition of the conduit based on the comparisons.

Claim 3. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes a strand that incorporates a mechanism as a means to mark location of damage such as ~~but not limited to, fluorescent debris or a fluorescent dye.~~

Claim 4. (Currently amended) The monitoring device of claim 2 wherein the ~~sensor set~~ said monitoring device includes at least one temperature sensor, ~~and the baseline operational parameters include the said temperature sensor:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall temperature spectrum characteristics of the conduit.~~

Claim 5. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one vibration sensitized medium, ~~sensor and the baseline operational parameters include the said vibration sensor:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall vibration spectrum characteristics of the conduit.~~

Claim 6. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one conduit electro-magnetic interference (EMI) sensitized medium, ~~sensor and the baseline operational parameters include the said EMI sensor:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall spectrum of EMI characteristics of the conduit.~~

Claim 7. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one ~~[strand-of]~~ temperature sensitized medium, ~~and the baseline operational parameters include the said strand of temperature sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall characteristics of the strand.~~

Claim 8. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one strand of corrosivity sensitized medium, ~~and the baseline operational parameters include the said strand of corrosivity sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall spectrum of corrosivity characteristics of the strand.~~

Claim 9. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one strand of chafing sensitized medium, ~~and the baseline operational parameters include the said strand of chafing sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall characteristics of the strand.~~

Claim 10. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one strand of pressure sensitized medium, ~~and the baseline operational parameters include the said strand of pressure sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall characteristics of the strand.~~

Claim 11. (currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one strand of chemically sensitized medium, ~~and the baseline operational parameters include the said strand of chemically sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall characteristics of the strand.~~

Claim 12. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor-set~~ includes at least one strand of piezoelectric sensitized medium, ~~and the baseline operational parameters include the said strand of piezoelectric sensitized medium:~~ (i) means; (ii) variances; (iii) range; (iv) ~~and the overall characteristics of the strand.~~

Claim 13. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one strand of base metal coated medium, ~~and the baseline operational parameters include the said strand of base metal coated medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.~~

Claim 14. (Currently amended) The ~~device~~ set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one strand of noble metal coated medium, ~~and the baseline operational parameters include the said strand of noble metal coated medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.~~

Claim 15. (Currently amended) The ~~device~~ A sensor of the set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one strand of clad silica sensitized medium, ~~and the baseline operational parameters include the said strand of clad silica medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.~~

Claim 16. (Currently amended) The ~~device~~ A sensor of the set of sensors of claim ~~[[2]]~~ 43 wherein the set of sensors ~~sensor set~~ includes at least one strand of fluorescent doped sensitized medium, ~~and the baseline operational parameters include the said strand of fluorescent doped sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.~~

Claim 17. (Currently amended) The ~~apparatus~~ monitoring device of claim 2 further comprising a communication link, and a communication control circuit coupled to the programmed processor and to the communication link, the communication control circuit being adapted to communicate information and data over the communication link.

Claim 18. (Currently amended) The ~~apparatus~~ monitoring device of claim 2 further comprising a visual indicator ~~coupled to the processor for receiving the output signal generated by the processor, and for providing a visual indication of the diagnostic condition of the conduit based on the output signal. ; and~~

coupled to the centralized data processor of claim 1 for purposes of sending the output signal generated by the processor of said monitoring device.

Claim 19. (Currently amended) The sensitized media of a sensor of the set of sensors of claim ~~[[2]]~~ 43 ~~providing wherein the sensor provides~~ a means for coupling to a plurality of conductors and connectors at spaced apart locations along the branches; and a terminator connected to a first connector; and,
a means to attach appropriate signals ~~including, but not limited to, direct current or alternating current electricity, radio waves, audio signals, fluids, and beams of light ; and~~
a means to attach a signal analysis instrument.

Claim 20. (Currently amended) Claim 20. (Currently amended) The ~~sensitized media of~~ sensors of the set of sensors of claim ~~[[2]]~~ 43 ~~wherein the sensors in which the signal generators with the signal detectors and the microcontroller processor of claim 3~~ comprise a means to quantitatively measure changes in signals and secondary effects as a means to detect the presence, degree, and location of deterioration or damage. ~~to the insulation material.~~

Claim 21. (Currently amended) The sensitized media of a sensor of the set of sensors of claim ~~[[2]]~~ 43 wherein the sensor is made up of diverse sensitized media including hollow, filled or solid strands, fibers and strips made with combinations of inorganic, organic or man-made materials.

Claim 22. (Currently amended) The sensitized media of a sensor of the set of sensors of claim ~~[[2]]~~ 43 in which the sensitized media ~~insulation material~~ comprises ~~a mixture of dielectrics~~ at least one dielectric.

Claim 23. (Currently amended) The sensitized media of a sensor of the set of sensors of claim ~~[[2]]~~ 43 wherein the sensitized media is in coaxial relationship ~~to the insulated cores~~ with linear, curvilinear, or helical format.

Claim 24. (Currently amended) The sensitized media of a sensor of the set of sensors of claim ~~[[2]]~~ 43 fabricated on an inner layer ~~of the insulation~~.

Claim 25. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 fabricated on [[the]] ~~an~~ outer surface of ~~the insulation~~. __

Claim 26. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that conduct electricity~~[[.]]~~ ; and
said sensitized media evidence at least one optical phenomena when stimulated by a mechanism that causes the said optical phenomena.

Claim 27. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that conduct light ~~[[.]]~~ ; and
said sensitized media evidence at least one optical phenomena when stimulated by a mechanism that causes the said optical phenomena.

Claim 28. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that conduct electromagnetic ~~waves~~; signals;

Claim 29. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that conduct acoustic ~~waves~~; signals;

Claim 30. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that act as optical waveguides.

Claim 31. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 that act as optical transmission lines.

Claim 32. (Currently amended) The sensitized media of a sensor of the set of sensors of claim [[2]] 43 when joined by a multiplicity of interfaces ~~connectors~~ to create a plurality of sections.

Claim 33. (Currently amended) The conduit monitored by the monitoring device of claim 2 comprised of one or more non-insulated conducting strands.

Claim 34. (Currently amended) The conduit monitored by the monitoring device of claim 2 comprised of one or more insulated conducting strands.

Claim 35. (Currently amended) The conduit monitored by the monitoring device of claim 2 when joined by a multiplicity of couplings to create a plurality of sections.

Claim 36. (withdrawn) The conduit of claim 2 the material whereof is comprised of a liquid.

Claim 37. (withdrawn) The conduit of claim 2 the material whereof is comprised of ceramic.

Claim 38. (withdrawn) The conduit of claim 2 the material whereof is comprised of metal.

Claim 39. (withdrawn) The conduit of claim 2 the material whereof is comprised of plastic

Claim 40. (withdrawn) The conduit of claim 2 the material whereof is comprised of glass

Claim 41. (withdrawn) The conduit of claim 2 the material whereof is comprised of a concretion.

Claim 42. (Currently amended) A method for ~~diagnosing and prognosing the~~ assessing a health status of conduits, the determining method ~~comprising the steps of:~~

determining ~~[[the]]~~ requirements for monitoring the system of conduits;

~~defining the functions of the distributed computers, diagnostic and prognostic software to meet the requirements;~~

selecting ~~[[the]]~~ parameters to be sensed and monitored;

selecting ~~[[the]]~~ components consisting of electronics, hardware, software, firmware and set of discrete sensors and strips of sensitized medium to implement said ~~[[the]]~~ functions;

designing and manufacturing ~~[[the]]~~ a form and fit of the monitoring device comprised of said components;

applying, placing, attaching or embedding the monitoring ~~apparatus~~ device and sensors consisting of at least one strand of said sensitized medium along the length of ~~said a~~ conduit, wherein said strands of sensitized medium has a first end and a second end, said strands of sensitized medium being placed such that damage inducing factors such as ~~[[an]]~~ a solid object, gas, liquid, powder or electromagnetic waves ~~contacts~~ contact said sensitized medium prior to contacting ~~said a~~ conduit;

determining by a combination of measurement by signal processing and deductive algorithms whether, when, ~~and~~ where and to what extent said damage inducing factors have damaged each of said multiplicity of sensitized medium;

comprising the steps of:

[[I]] using said monitoring apparatus to periodically monitor at least a portion of the said system of sensors ~~of the system of conduits~~ at given points in time over a first extended period and, for each point in time, storing in a digital memory a data couplet containing information concerning ~~[[the]]~~ said parameters, and the point in time; and

using analog circuits to condition, sample, hold, and digitize the signals from the said sensors into parameter values; and

forming tuples that represent the time of the sample, identity of the sensor, and ~~[[the]]~~ said parameter values; and

using digital processor~~[[s]]~~ algorithms to identify ~~couplets~~ tuples having normal values within a predetermined range; and

providing an indication of steady state characteristics if ~~[[the]]~~ said parameter values ~~readings~~ for at least a predetermined number of ~~couples~~ tuples are within a first predetermined range; and

providing a programmed diagnostic algorithm for assessing risk of damage to the sensor and extent of deterioration and damage to the monitored conduits; and

providing ~~an a-prognostic~~ algorithm for estimating ~~[[the]]~~ remaining useful life of the monitored conduits and components; and

providing a protocol for communicating ~~[[the]]~~ information about sensed damage, deterioration, and as well as diagnostic ~~and prognostic~~ information concerning ~~[[the]]~~ a health status and integrity of the monitored conduits, components and system; and

[[II]] performing a first test sequence on each of the multiplicity of said sensitized medium for the purpose of forming a baseline of characteristic parameters of each said sensitized medium for future reference by measuring ~~the characteristics~~ characteristic parameters and storing ~~the characteristics~~ characteristic parameters in accessible storage medium or location for future use ~~[[.]]~~ ;

[[III]] from time to time performing the same said first test sequence on each of the multiplicity sensitized medium;

making a test measurement for the purpose of determining if said measured ~~characteristics~~ characteristic parameters are substantially equal to previously measured ~~characteristics~~, characteristic parameters, the possible outcomes being:

[[a]] there is no measurable change to the sensitized portion of the medium; and

[[b]] there is measurable change to the sensitized portion of the medium; and

[[c]] the medium is disrupted, ~~[[i.e.]]~~ broken, eroded, cut through or dissolved; and

choosing whether to repeat said step of ~~measuring and said step of determining at another point of said medium~~; test measurement of said sensitized medium; and

if the choice is to repeat, then repeating said steps of measuring and determining; and

[[IV]] with the digital processor, using a deductive algorithm along with any a priori probability information to:

[[a]] process data from said measuring of said multiplicity of sensitized medium into characteristic information; and

[[b]] determine any change of said ~~characteristics~~ characteristic parameters from recorded ~~baseline characteristics~~ characteristic parameters; and

[[c]] record the ~~information~~ parameters for later use; and

[[d]] ~~choosing~~ choose whether to measure to locate ~~the position of the change~~; and

if the choice is to locate then measure ~~the location of the change~~ using either direct calculation based on ~~[[the]]~~ response to the applied signal; or apply a measuring technique ~~such as reflectometry on a waveform conducting medium~~; and record the measured value and temporal information if available; and using a calculus estimate the degree of damage for each said sensitized media at each recorded point of damage, for each time if temporal information is recorded.

Claim 43. (New) A set of sensors that are sheets, strips or strands of at least one sensitized medium, said sensors so constructed that end-to-end said sensors are essentially opaque to electrical signal transmission; and

said sensors being positioned with respect to the conduit to provide information concerning the environment and real or potential damage and deterioration to the conduit; and

said sensors producing at least one optical phenomena when stimulated by a mechanism that causes the said optical phenomena; and

said sensitized mediums selected from mediums that are capable of supporting or conducting an electrical current and voltage, electromagnetic signals, optical signals, audio signal, shock waves, and liquids with the purpose to provide a means for controls and stimuli to the said sensitized medium, and

measures of parameters of said sensitized mediums include: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.